Pacific Science (1979), vol. 33, no. 1

ABSTRACTS OF PAPERS

Third Annual Albert L. Tester Memorial Symposium 13–14 April 1978[1]

The Albert L. Tester Memorial Symposium is held in honor of Professor Albert Tester who, at the time of his death in 1974, was Senior Professor of Zoology at the University of Hawaii. The faculty and students of the Department of Zoology proposed an annual symposium of student research papers as a means of honoring, in a continuing and active way, Dr. Tester's lively encouragement of student research in a broad range of fields within marine biology. Papers reporting original research on any aspect of biology are solicited from students at the University and these papers are presented at the symposium, which takes place during the spring semester. Income from contributions to the Albert L. Tester Memorial Fund of the University of Hawaii Foundation are used to provide two prizes for the best papers by graduate students in the Department of Zoology. Papers are judged on quality, originality, and importance of research reported, as well as the quality of the public presentation. Judges include several members of the faculty of the Department of Zoology as well as winners of the symposium from the preceding year, when possible. In addition, a distinguished scholar from another university is invited to participate in the symposium as a judge and to present the major symposium address. This year Dr. Karel F. Liem, Henry Bryant Bigelow Professor of Ichthyology at Harvard University, participated in the symposium.

Behavioral Isolation and the Origin of Species[2]

LORNA H. ARITA[3]

The genetic identity between species is maintained through reproductive isolating mechanisms. These mechanisms are classified into two groups: premating and postmating barriers. In this study, the ethological isolation (a premating barrier) of two stocks of *Drosophila adiastola* Hardy was determined. The stock collected in 1969, M55G17, experienced several "crashes" in population size while in the laboratory; whereas T79B3, the stock collected in 1975, had not gone through such conditions. Each stock was derived from a single female from West Maui.

Using male choice experiments, the number of homogamic versus heterogamic matings were recorded. This was accomplished by direct observation or the dissection of females to determine sperm presence in the reproductive tract.

The results showed an asymmetrical isolation where T79B3 females rarely accepted M55G17 males but where T79B3 and M55G17 females randomly accepted T79B3 males. From these results, there is an indication of a degree of ethological isolation

[1] Manuscript received August 1978.
[2] This work was supported by National Science Foundation grant no. BMS74-15506 to D. Elmo Hardy.
[3] University of Hawaii, Department of Entomology, Honolulu, Hawaii 96822.

evolving between the stocks. Also, the results indicate that the development of reproductive premating barriers may arise allopatrically rather than develop as a reenforcer of postmating barriers when sympatry is reestablished.

Agonistic Communication and Dominance in Hawaiian Yellow Tangs, *Zebrasoma flavescens* (Acanthuridae)

LAWRENCE J. BAER[4]

Data were collected from bouts observed after the introduction of an intruder to five residents. The outcome of these bouts was analyzed for individual pair dominance by examining win-loss-draw results. Interindividual interaction dyads were classified according to the dominance relationship, size, sex, and residence history of the fishes. Information analysis was then used to examine signal-response coupling and the roles of dominance and sex in information transmission. Determination of the relative contributions of signals to the total response pattern was made. Chi-square analysis was performed on individual action pattern types within the signal-response matrix to help discover the function of each modal action pattern.

Attributes of dominants were, in descending order of importance: prior residence, larger size, and being male. More information was transmitted from the subordinate to the dominant individual than in the other direction and greater transmission occurred when a female signalled a male than for any other sexual combination. A small number of aggressive signal types played a large role in the determination of response topography, an effect that was greater for males signalling females than for females signalling males.

Observations on the Vertical Distribution of the Chambered *Nautilus* in the Palau Islands

BRUCE A. CARLSON[5] and MIKE V. DEGRUY[6]

Field observations on the cephalopod mollusk *Nautilus* sp. (cf. *repertus*) from the Palau Islands indicate that it is one of the dominant organisms in deep-reef environments. Fifty-one animals were collected in July 1977 and 74 more were collected in February 1978. Depths of capture ranged from about 200 to 400 m, with temperatures varying from 7° to 10°C. Males were much more common than females in trap collections and only three juveniles were collected. One *Nautilus* was tagged with an ultrasonic transmitter and its vertical and horizontal movements were monitored from the surface using a unidirectional hydrophone over a 7-hr period.

[4] University of Hawaii, Department of Zoology, Honolulu, Hawaii 96822.
[5] University of Hawaii, Department of Zoology, Honolulu, Hawaii 96822.
[6] Waikiki Aquarium, Honolulu, Hawaii 96815.

The Ontogeny of Play in Captive Bengal Tigers and Its Social Ramifications

DAVID A. CLUGSTON[7]

The play behavior of three Bengal tiger cubs and their mother was investigated during the normal weaning period for the young, age 6 weeks to 6 months. Social play was found to be a method of determining a social hierarchy among the cubs. Partner preference, play initiation, and aggressiveness in playful interactions is related to rank and sex. Bengal tiger play is compared to other carnivores, and a theory for dispersal is put forth.

Auditory Sensitivity in Two Species of Hawaiian Squirrelfish[8]

SHERYL COOMBS[9]

Auditory sensitivity as a function of frequency has been determined using behavioral methods for several individuals from two squirrelfish genera, *Adioryx* and *Myripristis* (Holocentridae). *Myripristis kuntee* can detect pure tone sounds as low as −50 dB re: 1 dyne/cm^2 over a wide range of frequencies (300 to 2000 Hz). This is 10 to 30 dB more sensitive than the best sensitivity measured for *Adioryx xantherythrus* at 400 to 600 Hz. In addition, the frequency range of hearing for *M. kuntee* extends up to 3000 Hz, whereas *A. xantherythrus* can detect sounds only up to 900 Hz. Both species can hear sounds as low as 100 Hz.

The two genera sampled can be taxonomically separated into subfamilies on the basis of morphological variation in the auditory system. The genus *Myripristis* is characterized by an intimate connection between anterior projections of the swim bladder and the inner ear, whereas in the genus *Adioryx*, the swim bladder lacks projections and is separated from the inner ear by a considerable distance. Since for many teleost species, the swim bladder is considered an accessory auditory structure and has a known sound amplification function, the difference in auditory sensitivity between the two genera may be correlated with variations in swim bladder proximity to the ear and possibly with swim bladder shape. Differences in frequency range, however, are less likely due to swim bladder variations and may possibly be related to other peripheral differences, such as inner ear morphology.

[7] University of Hawaii, Department of Zoology, Honolulu, Hawaii 96822.

[8] This work was supported by National Institute of Neurological and Communicative Disorders and Stroke grant no. NS-09374 to A. N. Popper and by National Institute of Mental Health predoctoral fellowship 1 F31 MH07441-01 to the author.

[9] University of Hawaii, Department of Zoology and Laboratory of Sensory Sciences, Honolulu, Hawaii 96822.

The Protein Nutrition of *Sarotherodon mossambicus* in Seawater

RONALDO P. FERRARIS[10]

Sixteen semipurified diets were formulated to determine the optimum protein level and protein:energy (P/E) ratio for *Sarotherodon mossambicus*, formerly *Tilapia mossambica* (Perciformes, Cichlidae), in seawater. The protein, lipid, and carbohydrate sources were casein, soybean oil, and dextrin, respectively. Two series of experiments were conducted: the first used an isocaloric diet fed to groups of approximately 40 individuals weighing about 1 g each; the second used diets in which protein was replaced by carbohydrate at different levels fed to groups of approximately 50 individuals weighing about 0.2 g each. Fish were fed ad libitum. Based on average daily weight gain, fish fed 40 percent protein had the fastest growth rate and the best feed conversion efficiency in both experiments. A P/E ratio of 89 to 95 mg/kcal, where protein provided approximately 50 percent of the energy, yielded the fastest and most efficient growth in diets with 430 to 450 kcal/100 g. Growth rate and conversion efficiency seemed depressed in diets where protein provided more than 50 percent of the energy, but were high in moderate protein efficiency ratios (PER). Lipid seemed to exert a stronger sparing action on protein than carbohydrates but harmed fish if fed at very high levels. Lipid appeared to regulate feeding rate in the first experiment, but in the second experiment, feeding rate seemed more dependent on the digestibility of the diet. Digestibility decreased and PER increased with decreasing protein content. Ash content was lower in fast-growing fish, and water content was high in starving individuals. A diet containing 25 percent protein, 18 percent lipid, and 27 percent carbohydrate is recommended for the culture of young *S. mossambicus* in seawater.

Observations on Humpback Whale Calves (*Megaptera novaeangliae*) in the Hawaiian Winter Assembly Area

PAUL H. FORESTELL[11] and LOUIS M. HERMAN[12]

The 1976–1977 assembly of humpback whales (*Megaptera novaeangliae*) in Hawaiian waters was studied during the major portion of its residence following annual migration from the summer assembly area. Observations were compiled from six different data sources, and 15 of the most detailed days were selected to provide an analysis of various trends throughout the season as a function of temporal and geographical differences. Using these data, the development of the calf following its birth in these waters is briefly discussed and related to observations on the composition of calf-pods across the season. It is hypothesized that increases in the size of the pods that calves are found in as the season progresses may be related to the age of the calf. This proposed relationship is used in estimating the total number of calves born in Hawaiian waters during the season. The implications for more detailed behavioral analysis of calf development are discussed.

[10] University of Hawaii, Department of Zoology, Honolulu, Hawaii 96822.

[11] University of Hawaii, Department of Psychology, Honolulu, Hawaii 96822.

[12] University of Hawaii, Department of Psychology and Hawaii Institute of Marine Biology, Honolulu, Hawaii 96822.

Hypometabolism and Hypothermia of the Genetically Obese Mouse[13]

DUANE L. GUERNSEY and WALTER K. MORISHIGE[14]

The genetically obese mouse (ob/ob) has been the object of intensive study. These rodents transmit obesity as an autosomal Mendelian recessive trait. Similar to childhood-onset or hyperplastic type of human obesity, the ob/ob mouse shows hyperinsulinemia, hyperglycemia, and insulin resistance by adipose and muscle. It has been shown that these animals are hypometabolic and hypothermic. When exposed to cold they die in 3 to 6 hr. Pretreatment with triiodothyronine prevents the decrease in body temperature. It has also been previously demonstrated that the hypothermia in cold is a result of an inability to increase thermogenesis. However, the obese mouse has normal circulating levels of thyroid hormones and the thyroid–pituitary axis is essentially normal. The possibility exists of an impaired peripheral response to thyroid hormones. Accordingly, we investigated nuclear triiodothyronine binding (believed to mediate expression of hormonal activity) and the cell membrane Na^+ pump (which has been shown to be the effector of thyroid thermogenesis and nonshivering thermogenesis of cold acclimation). We have found a dramatic reduction in ouabain-sensitive tissue respiration in muscle and liver from ob/ob mice and significantly depressed nuclear triiodothyronine binding capacity in liver and lung. Beta-receptors have been quantified and are shown in relation to other data.

The Contribution of an Electrogenic Sodium Pump to Burst Rate Regulation in the Cardiac Ganglion of *Portunus sanguinolentus* (Crustacea)

JON HAYASHI[15]

The cardiac ganglion of the crab *Portunus sanguinolentus* is a unit of nine neurons that can easily be isolated functionally intact. These neurons act synchronously and exhibit spontaneous periodic burst discharges. In crustaceans in general, they are solely responsible for the beat of the heart. Ouabain and strophanthidin inactivate a neuronal membrane Na^+–K^+ exchange pump via interference with Na^+/K^+-dependent ATPase. Application of these agents brings about a depolarization of 9 mV, which is accompanied by a threefold increase in burst rate, but impulse activity remains organized into bursts. In experiments in which the pump has been inactivated through perfusion with saline where Li^+ has been substituted for all of Na^+, a 10-mV depolarization is seen and bursting is disrupted and replaced by disorganized spontaneous impulse firing. A twice normal K^+ saline depolarizes the cells 8 mV, producing about a twofold increase in burst rate; K^+-free saline hyperpolarizes the cells 10 mV and slows the rate of bursting. After 20 min in K^+-free solution, when normal saline perfusion is resumed, the cells show an additional hyperpolarization of 1.5 mV, a cessation of bursting, and a slow depolarization to the original membrane potential. There is an eventual resumption of

[13] This work was supported by NIH-National Heart Lung and Blood Institute grant no. HL-19195 to W. K. Morishige.

[14] University of Hawaii, Department of Physiology, School of Medicine, Honolulu, Hawaii 96822.

[15] University of Hawaii, Department of Zoology, Honolulu, Hawaii 96822.

organized bursting at a normal rate, indicating recovery. Bursting rates can also be accelerated by passing constant inward current intracellularly and decelerated by application of outward currents. Membrane potential changes as a result of changes of the magnitude of the constant outward current produced by the electrogenic sodium pump may be one of several ways in which the bursting rate of the cardiac ganglion is modified. Furthermore, the cessation of bursting when switching from K^+-free to normal saline, seen also upon recovery from strophanthidin exposure, is interpreted as due to an absence of the small cell activity that normally initiates each burst. The small cells are thought to be hyperpolarized by increased (relative to normal) activity of the Na pump (as a result of Na accumulation during the period of pump inhibition) and a resultant increase in outward current. This conclusion is supported by the evidence that upon switching from a Li^+ saline to a Na^+ saline, membrane potential hyperpolarizations occur at a rate requiring tens of minutes, due to the fact that pump turn on is now slowed because of the initial low concentration of Na^+ within the cell.

The Biosystematics of the *mimica-kambysellisi* Subgroup of the "Modified Mouthparts" Species Group of Hawaiian *Drosophila*[16]

MELANIE W. Y. KAM[17]

The endemic *Drosophila* (Diptera) species of Hawaii show elaborate courtship behavior which evolved as a principal premating reproductive isolating mechanism among closely related species. The courtship behavior is manifested morphologically by ornate secondary sexual characters in the males, while the females possess a morphology typical of *Drosophila* (Carson and Kaneshiro, Ann. Rev. Ecol. Syst. 7, 1976). One such character exhibited by males is a modified labellum and mediproboscis adapted for grasping the female's genitalia during courtship (Speith, Univ. Texas Publ. 7103, 1966). The modification can range from a simple elongation and enlargement of the mouthpart spines to an extreme alteration of the shape and degree of sclerotization of the spines and margins of the labellar lobes. The relatively large and heterogeneous group of *Drosophila* that possesses these modifications is designated as the "modified mouthparts" species group.

A comparative morphological study of the male mouthparts of one of its subgroups, the *mimica-kambysellisi* subgroup, was undertaken in an attempt to clarify the taxonomic status of its species. It was found that definite morphological differences and similarities of the mouthpart spines do exist between the species and that they may be used to (1) differentiate between the *mimica-kambysellisi* subgroup and other subgroups of the "modified mouthparts" species group; (2) separate the species into complexes; and (3) differentiate between otherwise morphologically similar species of the subgroup.

An investigation of the larval substrates of the species of the subgroup was also undertaken. The results indicate that each complex is plant part specific in terms of larval substrate (which is also the same substrate in which oviposition occurs).

[16] This work was supported by National Science Foundation grant no. DEB 74-22532 to H. L. Carson and grant no. DEB 76-18042 to D. E. Hardy.

[17] University of Hawaii, Department of Entomology, Hawaiian Drosophilidae Project, Honolulu, Hawaii 96822.

Hydroxyl Radical Production Involved in NADPH-Dependent Lipid Peroxidation of Rat Liver Microsomes

CHING-SAN LAI[18] and LAWRENCE H. PIETTE[19]

The spin traps, 5,5-dimethyl-1-pyrroline-1-oxide and phenyl *t*-butylnitrone, were used to investigate the primary free radical involved in NADPH-dependent lipid peroxidation of rat liver microsomes. We previously reported that a NADPH- dependent hydroxyl radical ($OH^{\cdot}$), which may be the primary free radical that initiates lipid peroxidation, is generated in liver microsomes (Lai and Piette, Biochem. Biophys. Res. Comm. 78:51, 1977). The hydroxyl radical production is well correlated with the malondialdehyde production in lipid peroxidation during NADPH oxidation. The possibility that cytochrome p-450 reductase is involved in NADPH-dependent lipid peroxidation is discussed. Evidence is also presented that $OH^{\cdot}$ radical production in microsomes during induced lipid peroxidation occurs primarily via the classic Fenton reaction.

The Dentition of Seven Species of Butterflyfish (Chaetodontidae) and Their Related Feeding Behavior

PHILIP MOTTA[20]

The dentition of seven species of butterflyfish (Chaetodontidae) was examined using scanning electron microscopy. The differing species encompass various feeding guilds. *Chaetodon miliaris*, primarily a plankton feeder, occasionally feeds on the benthos; *C. kleinii* is a planktivore; *C. unimaculatus* is an omnivore feeding mostly on coral; *C. auriga* is an opportunistic omnivore feeding mostly on the benthos, tearing off pieces of sessile organisms; *C. ornatissimus* is a coral feeder deriving significant nourishment from coral mucus; *C. trifasciatus* is an obligate coral feeder; and *Megaprotodon strigangulus* is a specialized obligate coral feeder. The dentition and jaws show a morphology adapted to their respective feeding habits. *C. miliaris* and *C. kleinii* have six rows of teeth ranging from hooked villiformlike teeth to spadelike incisors on the periphery; *C. unimaculatus* has only a few rows of teeth, contrasting strikingly from hooked villiformlike teeth to broad shovellike peripheral teeth; *C. auriga* has up to ten rows similar to *C. miliaris*; *C. ornatissimus* has numerous rows of equal-length hooked villiformlike teeth; and *C. trifasciatus* and *M. strigangulus* both have numerous rows of long villiformlike teeth of essentially all the same length.

[18] University of Hawaii, Department of Biophysics, Honolulu, Hawaii 96822.

[19] University of Hawaii, Cancer Center of Hawaii, Honolulu, Hawaii 96822.

[20] University of Hawaii, Department of Zoology Honolulu, Hawaii 96822.

Some Effects of Sewage Effluent on Epifaunal Communities in Southern Kaneohe Bay, Oahu, Hawaii[21]

EDWARD B. RASTETTER[22] and WILLIAM J. COOKE[23]

The effect of sewage effluent on tropical epifaunal communities was studied by following the establishment and initial development of fouling association on PVC panels. Panels exposed near the outfall during 2-week periods of sewage flow had significantly different communities than those exposed during periods of no sewage flow. High water motion coupled with the presence of sewage allowed the development of a diatom film of sufficient thickness to smother earlier settling organisms and prevent the settling of later larvae. Colonial didemnid tunicates were favored during periods of sewage flow, as was expected by their heavy dominance in mature communities established under conditions of continuous discharge. Sequential photographs revealed that macrofoulers (barnacles, serpulids, and tunicates) could settle within 24 to 48 hr after panel immersion. The use of sequential photographs of fouled surfaces to study growth, competition, and the effects of factors external to the community is also discussed.

Ecological Limiting Factors and the Function of Territoriality in the Anemonefish *Amphiprion melanopus*

ROBERT M. ROSS[24]

Field observations and experiments on the Indo-Pacific anemonefish *Amphiprion melanopus* at Guam show that it colonizes the aggregating sea anemone *Physobrachia douglasi* extensively and nearly exclusively. There are an average of four fish per colony. The total standard length of anemonefish at each aggregation is highly correlated with the total area covered by resident anemones, suggesting both a carrying capacity and some form of social control of growth of anemonefish. Intercolony migration of juveniles, as well as larval recruitment, may contribute to maintenance of the optimum colony size. Adults do not migrate.

Both juveniles and adults defend territory. Juvenile territories are mutually exclusive areas within the confines of the anemone aggregation. Adult territories are an order of magnitude larger than the area covered by the anemone aggregation. Though territories of mated females and males overlap completely, female emphasis is peripheral relative to the male. Adult conspecific intruders are attacked more heavily and at greater distances than are juveniles. Intraspecific territoriality in juveniles probably reflects the limited availability of critical habitat. In adults it may function to protect the pair bond. Interspecific aggression is less intense and appears to protect both the spawn and host anemones from various predators. Evidence for interspecific feeding territories is weak.

[21] This work was supported by Naval Ocean Systems Center contract N00123-76-C-0841 to the Research Corporation of the University of Hawaii.

[22] University of Hawaii, Research Corporation, Honolulu, Hawaii 96826.

[23] University of Hawaii, Department of Zoology, Honolulu, Hawaii 96822.

[24] University of Hawaii, Department of Zoology, Honolulu, Hawaii 96822.

The Rise and Fall of *Eucheuma* on Coconut Island

DENNIS J. RUSSELL[25]

In May 1975, a newly found strain of *Eucheuma striatum*, a red alga, was flown to Hawaii from the Philippines and planted on the northwestern reef flat of Coconut Island in Kaneohe Bay, Oahu. By March 1976, it had grown to an estimated 50 to 100 metric tons and become the concern of both scientists and the general public. Research conducted to find the causes of its success showed that it was highly dependent on the cultivation activities of man, was ill-suited as a colonizer, was limited by simple barriers and environmental conditions, suffered from grazing, and required constant immigration to maintain its population size. Nevertheless, with proper management, a highly productive, easily controlled, integrated mariculture project could be implemented using this strain of *Eucheuma striatum*.

Genetic Similarity and Variation in the Hawaiian Goatfishes (Mullidae)

CLYDE S. TAMARU[26]

A starch-gel electrophoretic study of 22 enzymes and three nonenzymatic proteins encoded by 35 structural gene loci was conducted to measure the relationships among nine species of goatfishes and the amount of genetic variation in the goatfish populations in Hawaiian waters. In addition, it was hoped to supplement the limited number of morphological characters that aid in the identification of these species.

In general, the goatfishes were found to be equally variable with other organisms for which estimates of levels of protein polymorphisms (P) and average heterozygosities (H) are available; $\bar{P} = 21.5$ percent, with a range of 9.1 to 31.4 percent, and $\bar{H} = 3.8$ percent, with a range of 1.5 to 7.1 percent. The largest number of alleles found at a single locus was five in *Parupeneus pleurostigma* at the locus encoding adenosine deaminase.

The mean genetic similarity among all nine species surveyed is 0.32, with a range of 0.09 to 0.64, which is on the lower part of the range observed in a variety of organisms. The similarity coefficients were found to correspond with the three designated genera, *Parupeneus*, *Upeneus*, and *Mulloidichthys*, which are based on morphological characteristics. The one representative of the genus *Upeneus* was found to be more closely related to the genus *Mulloidichthys*. Of practical significance, the electrophoretic mobilities of only six isozymes, lactate dehydrogenase A_4 and C_4 homopolymers, creatine kinase A_2 homodimer, and the supernatant forms of malate dehydrogenase, isocitrate dehydrogenase, and aspartate aminotransferase extracted from muscle, eye, and liver, can be used to unambiguously identify all nine species for either the adult or juvenile forms.

[25] University of Hawaii, Department of Botany, Honolulu, Hawaii 96822.

[26] Oceanic Institute, Waimanalo, Oahu, Hawaii 96795.

Relationships of the Blue Shark, *Prionace glauca*, and Its Prey Species Near Santa Catalina Island, California[27]

TIMOTHY C. TRICAS[28]

Relationships of the blue shark, *Prionace glauca*, and its prey species were studied from March 1975 to March 1976 at Santa Catalina Island, California. Stomach contents of sharks indicate the northern anchovy, *Engraulis mordax*, as the principal prey for sharks in the study area. Beaks of at least thirteen species of pelagic cephalopods occurred in the diet and show that cephalopods, especially histioteuthid squid, comprise major prey for blue sharks in oceanic waters more distant than the study area. Sharks also exploited species associated with inshore habitats. Planktivorous fishes (e.g., blacksmith, *Chromis punctipinnis*, and jack mackerel, *Trachurus symmetricus*) were found in sharks captured near the island shore. In addition, sharks moved inshore to feed on winter spawning schools of market squid, *Loligo opalescens*. Telemetric trackings of sharks in offshore waters indicate a general foraging pattern near the surface, with increased activity at night. In these same waters, anchovies schooled during the day and then dispersed in surface waters at night. Rates of anchovy digestion for captive sharks were compared with digestive states of prey recovered from wild sharks and provide evidence that sharks fed primarily from around midnight through dawn.

Molecular Mechanisms of Nutrient Absorption in *Macrobrachium rosenbergii*

JAMES A. WYBAN[29]

Alanine absorption in the midgut of the freshwater prawn *Macrobrachium rosenbergii* was investigated in an attempt to characterize the underlying molecular mechanisms. The transmural electrical potential difference (PD) across the perfused midgut (in vitro) was measured while the gut was bathed and perfused with the standard prawn ringer (430 mosm). Under these control conditions a PD $= -1.6 \pm 0.2$ mV (mucosa negative) was recorded. Addition of L-alanine to the mucosal perfusate increased the PD. This increase in transmural PD (ΔPD^{ala}) was a function of mucosal alanine concentration. A plot of ΔPD^{ala} versus [ala] was hyperbolic, while a plot of $1/\Delta PD^{ala}$ versus 1/[ala] was linear. The alanine-evoked PD was stereospecific and Na^+-dependent: D-alanine had no effect on control PD and no ΔPD^{ala} resulted when the mucosal Na^+ concentration was zero. Using radioactive alanine, flux measurements showed a net flux of alanine from mucosa to serosa. Glucose added to the perfusate also increased the mucosal negativity and this ΔPD^{glu} was independent of ΔPD^{ala}. Alanine and glucose together in the perfusate evoked a

$$\Delta PD^{total} = \Delta PD^{ala} + \Delta PD^{glu}$$

[27] This work was supported by Office of Naval Research contract N00014-75-C-204, under project NR-104-062, for the program of shark research of which this study is a part.

[28] California State University, Department of Biology, Long Beach, California 90840.
Present address: University of Hawaii, Department of Zoology, Honolulu, Hawaii 96822.

[29] University of Hawaii, Department of Zoology, Honolulu, Hawaii 96822.

Dipeptides containing alanine also evoked an increase in transmural PD. The peptide-evoked potential (ΔPD^{pep}) was not independent of the alanine-evoked PD,

$$\Delta PD^{total} \neq \Delta PD^{pep} + \Delta PD^{ala}$$

but was independent of the ΔPD^{glu},

$$\Delta PD^{total} = \Delta PD^{pep} + \Delta PD^{glu}$$

These results suggest the following: (1) a protein carrier molecule capable of cotransporting Na^+ and alanine from the mucosal solution across the apical membrane into the epithelial cell; (2) a peptide hydrolase capable of catalyzing the hydrolysis of alanine peptides located in or near the brush border so that the alanine released by hydrolysis is available to the alanine transport mechanism.

The Occurrence and Natural Habitat of the Mangrove Crab, *Scylla serrata* (Forskal), on Ponape and Guam

RICHARD E. DICKINSON[30]

The natural habitat of the mangrove crab *Scylla serrata* (Forskal) is described, and various physical data from habitats where mangrove crabs occur are presented. Physical data include temperature, dissolved oxygen, and salinity. *Scylla serrata* tolerated low dissolved oxygen levels in the field, as low as 0.7 ppm, and often experienced extended periods of aerial respiration. Crabs occurred in zones of continuously variable salinity, but evidence indicated that larger individuals, especially large males, occurred more often in water of high salinity (greater than 25 ppt).

Gut analyses were performed on crabs from Ponape and Guam. Ponape individuals fed primarily on the bivalve *Gelona papua* (Lesson). Guam individuals fed mostly on a benthic grapsid crab, *Ptychognathus ishii* Sakai. Other food items are listed. Fish were rarely eaten.

Tagging studies indicated that crabs may remain in the same channel or river for up to 1 month or more.

A series of morphometric measurements were made on individuals captured in the field. There is a sexual dimorphism in cheliped size; the growth rate of the male cheliped is faster than the growth rate of the female cheliped. The relationship of prey size and cheliped size as important factors regulating the distribution of mangrove crab is discussed.

Crabs were maintained in small cubicles and in water of different salinity. Twelve individuals molted at least once and percentage increase in growth agreed well with growth data from work done elsewhere.

[30] This abstract is of a paper that was to be presented by Richard E. Dickinson, based on his master's thesis at the University of Guam Marine Laboratory. Rick died only a few weeks prior to the symposium, cutting short a career of service to Micronesia that he had hoped for.